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# Instructional Role-Playing Video Game: Its Application to Physics' Equations of State Learning

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**Abstract.** The potential of video games for learning is now widely accepted among the community of Educational Technology. Multiple types of research have been conducted to see the proficiency of video games as an educational tool, and the effect on students' learning and performance of instructional video game approaches, which have elevated considerable interest in the thematic field of education research. The study assessed the effectiveness of instructional role-playing video games in learning physics equations of state concepts and problem-solving for junior high school students. Specifically, the study determined the performance level in Equations of State Problem Solving of junior high school students when concepts were taught through the conventional approach and through the Role Playing Video Game approach. The result indicated that the performance level in Equations of State problem solving of students taught using the role-playing video game approach was significantly higher than those taught using the conventional approach. Also, the Equations of State problem-solving performance level of students taught using the role-playing video game were satisfactory or better regardless of sex. Problem-solving through role-playing video games is an effective learning approach to learning the Equation of State concept. It is recommended that further research on the application of instructional Role-playing video games be considered in the teaching and learning of Physics concepts.

**Keywords:** Role-playing video game; Equations of state; Problem-solving, Teaching-learning approach.

## 1.0 Introduction

The integration of technology into education has significantly influenced how students learn and interact with content. With the prevalence of digital devices, students increasingly rely on technology for both educational and entertainment purposes. This shift highlights the potential of innovative teaching tools, such as video games, to support learning. Video games, a staple of modern entertainment, have evolved into mainstream media with applications beyond leisure, including education. Recent studies, such as those by Rashty (2003) and Whitton (2018), emphasize how digital games can create engaging and dynamic learning experiences, foster problem-solving, and motivate students through challenges and rewards. These qualities align closely with the goals of the

K to 12 Science Curriculum, which aims to develop innovative, critical thinkers equipped for complex scientific and societal challenges (DepEd, 2016).

In physics education, concepts such as the Equations of State are integral to understanding thermodynamics. However, these topics can be abstract and challenging for students, necessitating instructional approaches that enhance engagement and comprehension. Prior research highlights the potential of interactive and blended learning strategies. For instance, studies by Lubrica et al. (2016) and Dolipas et al. (2017) demonstrate that interactive science tools can spark curiosity and improve performance. Similarly, Teofilo et al. (2012) found that blended learning approaches lead to higher academic achievement. However, the specific impact of role-playing games (RPGs) on physics education remains underexplored.

This study aims to address this gap by investigating the effect of an RPG-based instructional approach on students' academic performance in Physics, focusing on the Equations of State. By bridging educational technology and physics pedagogy, this research contributes to understanding how innovative tools can enhance learning outcomes in science education.

## 2.0 Methodology

### 2.1 Research Design

The study applied an experimental quantitative approach that used a non-randomized control group pretest-posttest research design to determine the efficiency of an educational role-playing game in teaching and learning the Physics Equations of State: Boyle's Law, Charles' Law, and Ideal Gas Law. The purpose of a pretest-posttest design is to take measurements prior to and after employing a treatment on participants. Given this, the differences in the performance between groups may be assessed.

The role-playing video game "Adventures of You" was programmed using Role Playing Game (RPG) Maker 2015. The programmed role-playing video game integrated the Physics Equations of State concepts and problem-solving applications. The Equations of State concepts included in the study are the Ideal Gas Law, Boyle's Law, and Charles' Law. The game was installed in the computer lab so that students could access it. The student then logs in and plays the character named "You" in the installed game. The game is a journey of "You", exploring a virtual place called "Prontera." Along the character's journey in Prontera, you encountered different people who instructed him to do various activities that involved learning the equation of state concepts. On the way, the character faced problems and challenges related to activities where the Equations of State were integrated. In order to surpass the challenges and continue the journey, the user was required to solve the problems and overcome challenges by applying the Equations of State: Boyle's Law, Charles'Law, and Ideal Gas Law. As an example of the problem you encountered, you went into scuba diving with one of the persons you encountered, and while on scuba diving, there was a problem with the oxygen tank of the other character. In such a scenario, two variables of states (pressure, temperature, or volume) were given, and the missing third variable would be computed to solve the encountered problem.

### 2.2 Research Respondents

The population investigated consisted of students from six sections of Grade 10 classes of a University - Laboratory High School. Out of the possible number of students, six sections were sampled through a combination of purposive and convenience sampling, and participants were chosen based on their availability and whether they had already taken the topic at hand in their science class. There were two hundred fifty-five (255) respondents, of which 129 belonged to the control group, while 126 were included in the class using the role-playing video game method of instruction. The researchers only considered the sections that had not yet learned the chosen topic to ensure the students had little to no prior knowledge regarding the topic. Thus, researchers focused on 6 sections of Grade 10 students from the university.

### 2.3 Research Instrument

The study mainly compared academic performance in Physics' Equations of States concept among Grade 10 students taught through conventional and role-playing video game-based teaching-learning methods. It attempted to understand the potential of the role-playing video game teaching-learning method as an effective alternative way of teaching-learning.

### 2.4 Data Gathering Procedure and Analysis

The participants were asked to answer a questionnaire to preliminary test the student's prior knowledge of the topic. The questionnaire comprised several questions modified from the lessons integrated into the role-playing game (RPG) and included individual questions formed by the researchers. The pretest was conducted to select only respondents with homogenous initial knowledge of the Equation of State concept. After assigning the experimental group and control group, the intervention commenced. Both groups utilized the same lesson content and topics about Boyle's Law, Charles' Law, and Ideal Gas Law, but the groups were instructed with two different teaching-learning approaches. The control group was instructed using the conventional teaching approach where the topics considered were taught through direct instruction that relies mainly on the teacher serving as the resource, and the students had a more passive-receiver role. Conversely, the experimental group was instructed to use a role-playing video game approach. The Equations of State were introduced to the experimental group by playing the educational role-playing video game in the Grade 7 & 8 university Computer Laboratory. The study was conducted two days a week in a 50-minute class meeting per day for each class. Subsequently, the same participants took the questionnaire again. A control group was established to determine the possible effects of the game. Said group underwent the same pretest and posttest. The scores on the post-test were analyzed using a repeated-measures analysis (independent samples t-test) to see if the performance of the control and experimental respondents significantly differed from each other. The study used a 0.05 level of significance.

### 2.5 Ethical Considerations

The researchers followed ethical guidelines, where informed consent was obtained from all research participants, and permission was solicited from the university heads before the study was conducted.

## 3.0 Results and Discussion

Table 1 presents the performance level and compares the students' performance level in Physics Equations of State problem solving under the conventional approach of teaching-learning and the role-playing video game learning approach. Based on the data presented, 0.80% of the students under the conventional approach method of learning performed outstandingly, 30.95% satisfactorily performed, and 78.05% did not meet expectations. For students who underwent the Role Playing Video Game learning approach, 7.14 % of the students from the experimental group performed outstandingly, 23.81% very satisfactorily, and the rest (69.05%) did not meet expectations.

**Table 1.** Comparison of performance of the conventional approach and role-playing video game approach

| Performance Rating | Descriptive Equivalent | Teaching-Learning Approach Used | |
|---|---|---|---|
| | | Conventional | Role Playing Video Game |
| 90 and above | Outstanding | 0.800 | 7.140 |
| 75-89 | Satisfactory | 30.95 | 23.81 |
| 74 and below | Does not meet the expectation | 68.25 | 69.05 |

Table 2 compares the students' performance level in Physics Equations of State Problem Solving under the conventional teaching approach and students under the role-playing video game learning approach. Accumulatively, about 31% of the experimental group performed satisfactorily or better than the control group, with about 32%. The computed t-value of 5.986 is significant at a 0.05 level of significance, indicating a significant difference between the performance of the control group compared to the experimental group. The performance level in Physics' Equations of State concept of students under the instructional Role Playing Video game type of learning approach is significantly higher than that of students under the conventional learning approach.

**Table 2.** Analysis of the difference in performance of the conventional approach and role-playing video game approach

| Performance Rating | Descriptive Equivalent | Teaching-Learning Approach Used | | t | p |
|---|---|---|---|---|---|
| | | Conventional | Role Playing Video Game | | |
| 75 and above | FS-O | 31.75 | 30.95 | 5.986 | 0.015 |
| 74 and below | NME | 68.25 | 69.05 | | |

The table shows that the experimental group that has undergone the RPG had a significantly higher level of performance in Physics' Equations of State problem solving compared to the control group that had gone through conventional teaching methods. There has been overwhelming evidence that educational computer games outperformed the control group (nongames) in attaining factual knowledge (Almeida, 2012). This is further proved by Angelo et al. (2014) and Yubuno et al. (2019), who suggest improved cognitive competencies of students

in math, science, human anatomy, engineering, and technology when they use digital games. This finding indicates the favor of digital games in students' cognitive learning, as supported by Bai (2020).

Table 3 shows the performance level in Physics' Equations of State problem solving of students when grouped according to sex and comparison of the performance in Physics' Equations of State problem solving of male and female students who undergone the role-playing video game method of learning. As presented in the table, about 25.37% of the female students performed satisfactorily or better than the 22.04% of male students. About 6% of the females performed outstandingly, while about 8% of the male students likewise performed outstandingly. The rest of the female students (about 67%) and male students (about 70%) did not meet expectations. The t value of 0.263 is not significant at a 0.05 significance level. This implies that even though there are differences in the performance levels of both males and females, both still have the same level of performance in Physics' Equations of State problem-solving.

**Table 3.** Comparison of performance of male and female participants

| Performance Rating | Descriptive Equivalent | Male | Female | t | P |
|---|---|---|---|---|---|
| 90 and above | Outstanding | 8.47 | 5.97 | | |
| 85-89 | Satisfactory | 22.04 | 25.37 | 0.263 | 0.609 |
| 74 and below | Does not meet the expectation | 69.49 | 68.66 | | |

The table above indicates that role-playing video games have an equal influence on both male and female students' academic performance in Physics' Equations of State problem-solving. This finding is also congruent with the results of Dorji, Panjaburee, and Srisawasdi (2015), which have exhibited that there is no significant difference in the level of knowledge between male and female students when they go through a role-playing video game learning approach. This, however, does not support the study of Nadeem (2023), where the result of the study showed female students having a higher level of enjoyment towards the games compared to male students.

## 4.0 Conclusion

Based on the study's results, the problem-solving performance level of students in the Physics Equations of State under the conventional teaching-learning approach ranged from not meeting expectations to outstanding. This is likewise observed with students under the educational role-playing video game learning approach but with a significantly higher number of students with outstanding performance levels. The study shows a significant difference in students' performances in Physics Equations of State problem solving when taught with an educational Role Playing Video Game and the use of a conventional approach. In addition, role-playing video games is an effective approach in the teaching-learning process of the topic of physics equations of state concept. There was no significant difference in the level of performance of males and females, suggesting a near-equal performance level in Physics' Equations of State problem-solving. This signifies the identical perception of information of both males and females regarding role-playing video games. As a result, it can be said that educational Role-Playing Video Games are effective in schooling for educational goals.

Based on the conclusions, it is recommended that the academe consider Role-Playing Games as one of the effective teaching-learning methods. It could be used as a method of instruction, regardless of sex, in the teaching-learning process, especially in the Gas Laws concept. It is likewise recommended that more research be done on applying role-playing games to other concepts or other instruction fields.

## 5.0 Author contributions

Bretel B. Dolipas: formal analysis, investigation, writing—review and editing; Thrysha B. Dolipas: writing—original draft preparation, investigation, methodology; Christian Fabriga: writing—original draft preparation, conceptualization, investigation, supervision; Marius Garcia: visualization, conceptualization, investigation; Sebastien Duke Romero: visualization, writing—original draft preparation, writing—review and editing; Aeron Mactal: data curation, investigation, writing—review and editing, revision; Junel Silvio: data curation, writing—review and editing, revision.


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## 7.0 Conflicts of Interest

The authors declare no conflicts of interest.

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